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Lubrication

A Technical Publication Devoted to
the Selection and Use of Lubricants

THIS ISSUE

Lubrication of Iron
and Steel Smelting
and
Refining Machinery



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LUBRICATION

A TECHNICAL PUBLICATION DEVOTED TO THE SELECTION AND USE OF LUBRICANTS

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Lubrication of Iron and Steel Smelting and Refining Machinery

LUBRICATION of steel rolling mill machinery is always a popular topic. It permits discussion of centralized grease lubricating systems, of oil film bearings and the chemistry of lubrication. For this service, lubricants must be refined, compounded and protected so that they will function dependably under the most intensive conditions of heat and pressure, all the while subject to contamination from scale, salt, dirt and water.

Lubrication of machinery in the iron and steel industry, prior to rolling, is not so glamorous a topic. It is a dirty job, often involving exposure of the lubricants to the elements. There is a definite trend, however, towards centralized lubrication to improve the conditions. We plan to discuss this phase of the industry in this issue, from ore handling, etc., up to the rolling mill.

The invention of the Bessemer converter in 1856 marked the beginning of the age of steel. Iron had

figured prominently throughout the history of the world as the outstanding metal in the advancement of civilization. It sufficed until the world callously demanded volume. Then the beauty of the ages, wrought by hand over lengthy days of toil gave way to the inventive genius of man.

The blast furnace, the Bessemer converter, the open-hearth furnace and the rolling mill solved our problems of maximum production with low cost.

The chemistry of iron and steel then became a science, and the formulation of alloys with such elements as carbon, silicon, nickel, chromium, tungsten, vanadium, phosphorous and manganese, made possible the variable degrees of hardness, ductility and strength so necessary today.

Chemistry and Metallurgy, however, can

determine only the nature of the product. They cannot govern the rate of production of the mechanical equipment involved. That is an operational problem

LUBRICATION was a chore in the steel plant when the machinery was designed with lubrication as an after-thought. In those days the value of seals was not realized; most of the time the greater part of the lubricants used never performed their intended function — they just dripped or ran off too soon and dirt got in. This applied to gears as well as bearings. These were the good old days of suet slabs, when iron was puddled by hand; when a strong back was associated with a little knowledge.

The iron and steel industry of today has reversed this thinking. The designers pioneered the trend towards antifriction bearings, the oil film sleeve type bearing on the back-up rolls, the enclosed (oil lubricated) reduction gear sets. The management realized that these refinements in design required refinements in lubricants. They purchased accordingly, from a Petroleum Industry equally as anxious to contribute to the production schedules demanded.

Iron and steel contributed another vital factor to high speed production: The Lubrication Engineer. With his practical "know-how" in iron and steel he helped to translate the science of Lubrication into a practical procedure.



Courtesy of Trabon Engineering Corporation

Figure 1—Typical blast furnace lubricated by a Trabon system. Points ordinarily lubricated are the rollers on the revolving distributor, the distributor drive, the pivot points on the large and small bell beams, the anti-twist bearing and the sheaves.

which is very often dependent to a great extent upon lubrication. The science of lubrication, therefore, must be considered. The intensive operating conditions in the iron and steel plant call for a minimum of friction, and uniformity of bearing temperatures in the face of the most discouraging operating conditions. Hot water, acid fumes, salt, dirt, dust, etc., are examples of the objectional factors confronting the lubrication engineer.

Three distinct phases of operation are required in the smelting and refining of iron ores and scrap, for the purpose of converting them into workable grades of steel. Each involves its specific equipment. For example:

- 1—*Smelting*, which requires such equipment as the blast furnace with its hoist and materials handling equipment.
- 2—*Storage or mixing*, wherein the mixer is involved.
- 3—*Refining*, or converting of iron into steel involving either the Bessemer converter, the open hearth, or the electric furnace.

THE BLAST FURNACE

Iron ore as it is received from the mines must be reduced to a state of more or less pure iron in the blast furnace. Iron ores are combinations of iron and oxygen termed iron oxides. The blast furnace breaks up these oxides by the combined effects of burning coke, and the chemical reaction which is brought about by means of a limestone flux. The removal of silica and the formation of non-ferrous slag results. The latter rises to the surface of the

molten iron as the reduction process occurs.

A blast furnace consists of a vertical steel furnace or stack about eighty to sometimes over a hundred feet high and perhaps twenty to thirty feet in diameter at the hearth, suitably lined with high refractory material such as fire brick. At the top is the charging opening through which measured quantities of ore, limestone flux, and coke are charged periodically by the skip hoist. At the bottom are two other openings, located one above the other but at some distance apart around the periphery of the furnace. The usual angle between them will be 60 degrees though 90 degrees may be found in some cases. The difference in the height or elevation of these openings varies with the size of the furnace. The Cinder Notch, which is the upper opening, serves for the removal of slag or waste products, resulting from the de-oxidation or reduction of the iron ore; the Iron Notch or lower opening, serves for tapping or pouring of molten iron. In general, iron is drawn off at four to six-hour intervals in 200 to 400 ton batches.

Ore Handling

Ore is handled according to the manner of delivery. If it is shipped down from the range in ore boats, cranes or a special type of ore unloader are used. If it comes in by rail, a crane or car unloader transfers it to the ore bins. From these storage bins the various grades of ore, according to the type of pig iron desired, are in turn charged into a transfer car in measured quantities. This car travels on a track located parallel with the blast furnaces so that

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it can be made to serve any of their respective mixing bins as necessary. Further mixing is attained by delivery of the contents of the transfer car to the mixing bin.

The Skip Hoist

The charge is then ready for delivery to the electric lorry cars and subsequently to the skip hoist. This device runs on an inclined plane extending from the base of the mixing bins to the top of the blast furnace. Tracks are laid on this incline up which the skip hoist buckets are drawn to the top of the furnace by wire ropes. Usually a skip holds from three to four tons of ore or limestone and about half as much coke. Some buckets discharge by automatically turning over, others through a trip-operated hopper in the bottom like a modern gondola coal car. Charging is an important factor, in that uniformly successive layers of ore, flux and fuel are necessary to promote even melting and descent of the charge.

In order to prevent the escape of any furnace gas the charging opening at the top of the blast furnace is equipped with two cones or bells, one located above the other. As the contents of the skip fall upon the upper or little bell, it is lowered, the material dropping to the top of the big bell below. After a series of deposits from the little bell have been distributed around the big bell, the latter is allowed to drop, the charge sliding down into the

furnace below.

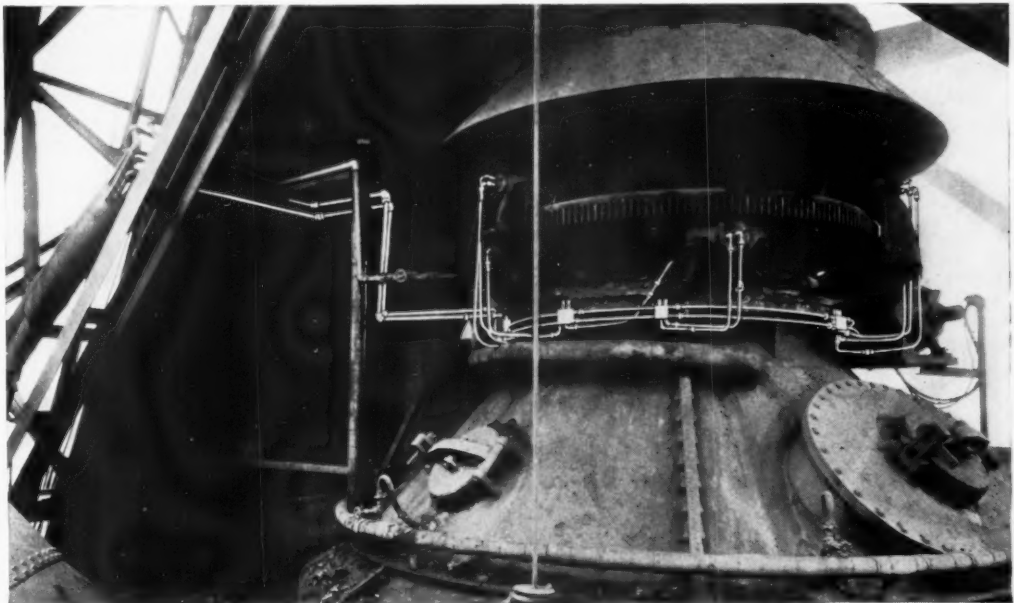
After a blast furnace is once started, it can be kept running indefinitely, often for several years, until the lining or some other part becomes so worn or damaged as to require renewal. At no time can it be said that charging is complete, and the furnace never cools down to any great extent while it is running.

The Smelting Process

The necessary blast of hot air which has been preheated by passage through hot blast stoves is introduced into the furnace near the bottom through ports known as tuyeres. This permits the coke to burn, the resultant heat bringing about the necessary reaction between the flux, ore, and carbon monoxide gas.

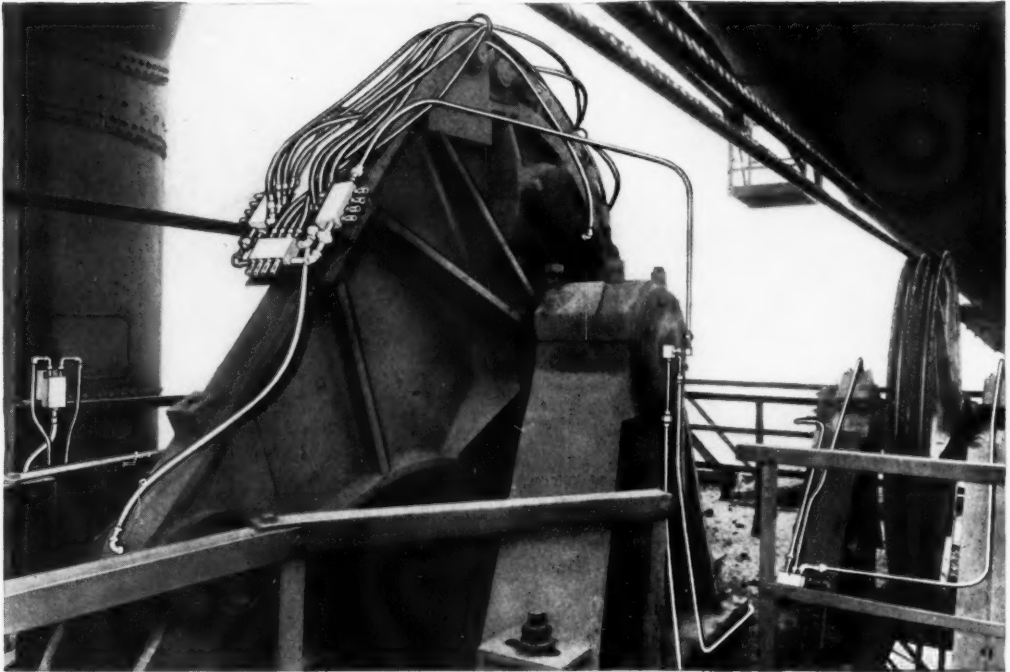
During the smelting process, molten iron separates from the impurities or slag and settles to the bottom of the furnace. As this reaction progresses, after about every four hours, the molten iron is tapped or drawn from the furnace, being drawn directly into ladles mounted on trucks to be stored in the mixer, for converting into steel while in the molten state, or poured from ladles to a moving conveyor with moulds to form pigs for shipment or cold charging.

The slag formed is run into ladles, or granulated with water in pits and hauled to the slag dump; it plays no further part in the production



Courtesy of The Farval Corporation

Figure 2 — Showing piping of a Farval system installed on the revolving distributor of a blast furnace top. 28 points of lubrication are served by this installation. Note main header piping running up the side of the skip hoist (top left), accompanied by a separately wrapped steam line.



Courtesy of The Farval Corporation

Figure 3 — View of the large bell beam on a blast furnace showing method of grouping the lubricant measuring valves on top of the fulcrum with flexible outlet connections to the link pin bearings. Note pressure control valve on stack at left. When sufficient pressure is developed to operate this valve, it makes contact to light a signal light at the central pumping unit in the hoist room below.

of either wrought iron or steel. It is, however, extensively used in the cement industry. When each pour is completed, the tapping holes or notches are plugged with a "clay gun" or steam actuated plunger device, which automatically drives balls of soft clay into the openings. During this operation, the blast is shut off, the material in the furnace settling to some extent.

Coke

A vast amount of soft coal is required to make the coke which goes into a blast furnace charge. Consequently, an expansive storage yard is required with machinery for moving the coal and grading it to size for the coke ovens. Small cars moved by an endless cable can be used effectually in the coal yard. Each car has a grip device which automatically fastens to the moving cable. This cable is not lubricated, so that a firm grip is assured. The cable sheaves must be lubricated, however, also the car wheel bearings, as well as the bearings and gears on the driving machinery and the eccentrics and bearings of the screens and grinding machines. These parts are greased by pressure gun, or bath lubricated as in the case of gears. The chief problem is to use enough grease, often enough, to keep coal dust from working into the bearing clearances.

Coke for blast furnace use must have high com-

pressive strength so that it can properly support the furnace charge and enable proper passage of the gases of combustion. This compressive strength is attained in part from the nature of the coking process, in part from the type of coal used, and in part by charging a light-medium viscosity petroleum oil into the coke ovens with the coal.

Air

Air is the most voluminous material used in the iron and steel industry. Approximately four to six tons of air are used to make each ton of pig iron. In the blast furnace this air furnishes the oxygen for the combustion process; in the Bessemer converter it provides the oxidizing effect. Though required in large volume, this air is used at a relatively low pressure, which is developed by turbo-blowers or huge horizontal or vertical compressors known as blowing engines, the air cylinders of which are called tubs. 15 to 30 pounds pressure is average.

The turbo-blowers are steam driven and in the modern plant their bearings are protected by an oil circulating system with all the necessary control valves, filtration and storage tanks which prevail in a modern turbine plant. Consequently a high quality turbine oil having rust and oxidation resistant properties is used. This must be capable of protecting the labyrinth packing exposed to the high surface speed.

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The blowing engines, however, are run on blast furnace gas or steam. They are slow speed — around 60 R.P.M. An interesting problem relating the B.T.U. content of the gas to lubrication prevails. If this gas is too high in B.T.U. value, it may cause back-firing in the blower engine. This creates a heat condition so intense as to burn away the lubricating oil on the engine cylinder walls. If an average B.T.U. value of 90 to 100 is maintained at the blast furnaces, however, there is little chance of back-firing. To protect the engine cylinders and rings this gas is cleaned and washed of flue-dust particles before usage.

Air tub operation is exceedingly important due to the fact that pressure must be kept on the lines to the blast furnaces and Bessemer converters at all times. As cleaning is practically impossible, the blower cylinder lubricant must be so refined as to give the minimum of carbonaceous accumulations in the air system. This can be promoted by insuring against feeding oil in excessive quantities to the air cylinders. Excess oil never improves lubrication and only leads to objectionable deposits, although since air tub pressures usually don't exceed 30 pounds cylinder temperatures never run much above 300 degrees Fahr.

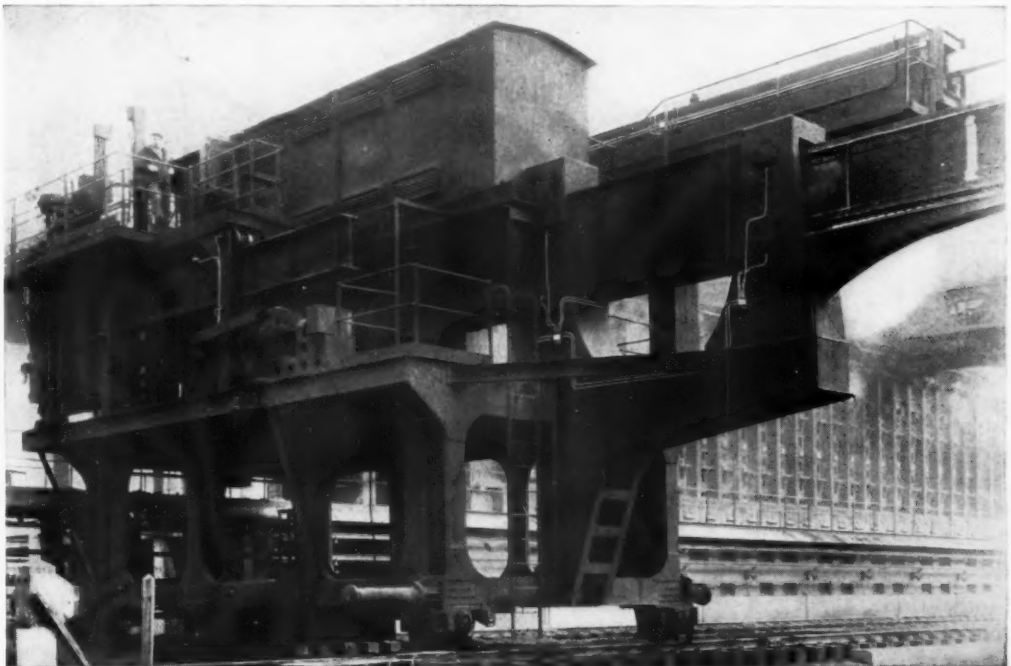
Lubrication of Blast Furnace Machinery

The parts to be lubricated around the blast furnace itself are confined to the wire rope, bull wheels,

sheaves, the large and small bell beams, gears and bearings of the skip hoist, unless the furnace is of the McKee type and fitted with a revolving top. This top requires lubrication of the worm gear driving unit and the bearings of the rolls upon which the top is turned. The former is a self-contained unit and lubricated by a worm gear lubricant of from 150 to 175 seconds Saybolt Universal Viscosity at 210° Fahr. The roll bearings are most safely served by a centralized greasing system using a lime soap grease usually of N.L.G.I. No. 1 or No. 2 Grade. Load and dirt are the chief problems, although considerable temperature variation may be encountered in northern parts of the country.

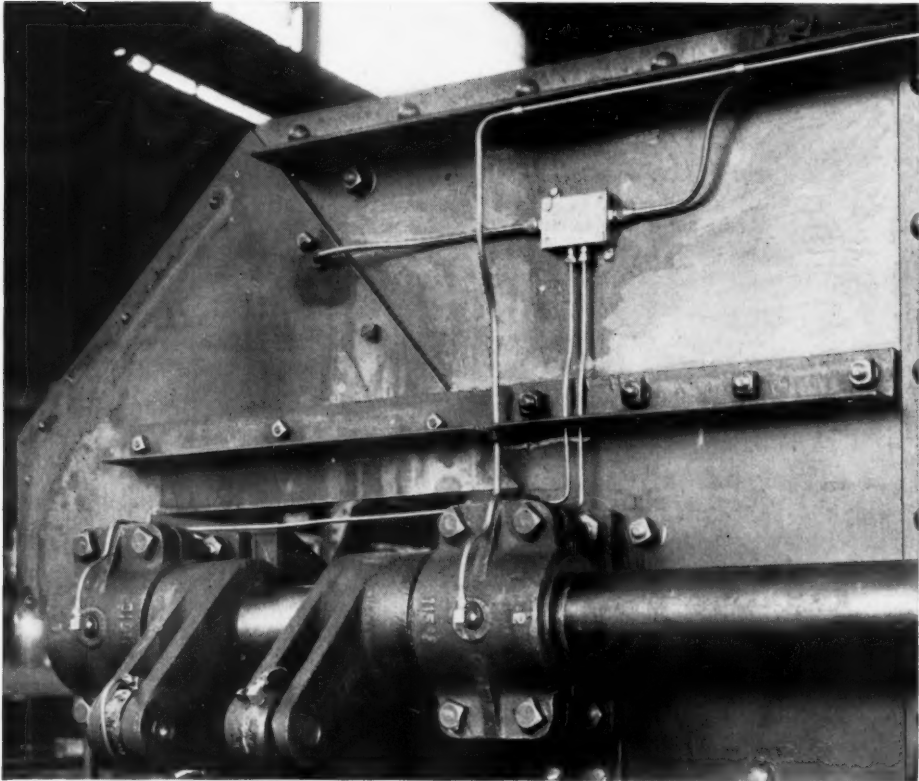
In addition to lubrication on a McKee top furnace, a petroleum grease also is used to lubricate the packing gland and thus effectually seal the gas and prevent excessive leakage between the revolving top and the shell. Blast furnace gas escapes when the sealing gland becomes hardened due to temperature and lack of lubrication.

As already stated, blast furnace operation requires huge turbo-blowers or reciprocating blowing engines which furnish the necessary low pressure blasts of air to the hot-blast stoves for pre-heating prior to delivery to the blast furnaces; the charging equipment which includes the wire ropes and bearings of the charging lorries and skip hoists, with their respective driving engines or motors; the



Courtesy of The Farval Corporation

Figure 4 — A coke pushing machine on which is installed a Farval manually operated lubricating system.



Courtesy of Trabon Engineering Corporation

Figure 5 — Showing the side of a transfer car where Trabon type A reversible feeders are used to lubricate line shaft points and linkage.

slag cranes, the steam or hydraulic clay guns, the ladle cars, storage bin feeders and miscellaneous gearing.

As most of this equipment is kept outdoors, or housed without benefit of heat control, obviously it may operate over a wide range of atmospheric temperatures, or radiated heat from the furnace itself. The blast furnace generates high heats and these are naturally radiated to the surroundings. Fortunately, however, much of the necessary mechanical equipment is not too close to the furnace, although the surrounding atmosphere usually has a high dust content which can cause difficulty in lubricating the blowing engines if the intake air is not filtered.

Bearings in turn can be grouped into two classifications:

- 1 — As involving automatic lubricators, or
- 2 — Exposed, hand-oiled conditions.

Steam engine, pump, turbo-blower, and electric motor bearings are largely oiled by some automatic though unit-type of lubricator. Those under cover should give little or no trouble. Exposed, hand-oiled bearings as are found on skip buckets and transfer

cars, etc., receive rougher service, and dust, dirt and rain are always detrimental factors. Such bearings have fairly high clearances, however, and operate at low speeds and pressures. Black oil can be used here to good advantage.

Gears and wire rope operating under conditions similar to bearings, though at perhaps higher working pressures, require a lubricant which will not drip from their surfaces, which will penetrate to the core of the ropes, and which will adhere tenaciously to the gear teeth in an even film. Normally, a straight mineral gear and rope lubricant from 600 to 2000 seconds Saybolt Universal Viscosity at 210 degrees Fahr. is used.

Yard Transportation

Hot metal, ladle and ingot cars are continually being moved around the yard. Hot metal and ladle cars may function to carry the iron poured from the blast furnace to the mixer or Bessemer converter. Ingot cars carry the solidified ingots from the open hearth, to the soaking pits at the blooming mills.

These cars may be equipped with either plain

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journal boxes and brasses, or roller bearings. The latter have come into quite extensive usage in the modern mills due to their savings in labor, inspection and lubricants. While it might seem that such bearings would be subjected to considerable heat, inasmuch as they are practically always in the open air, radiation can occur freely. As a result, such bearings, even before the ingots have solidified, usually will be comfortable to the touch.

Certain types of roller bearings are successfully lubricated by pressure grease application, directed via a drilled hole in the outer face of the journal and leading at a 45 degree angle from the base periphery of the journal where the bearing rolls are in contact.

Hot metal, slag, dust, dirt and variable loads are often the more important factors which must be considered.

All can affect the lubrication of plain journal bearings of the railway type because of the rough service and careless handling which so often prevail. In the roller bearing, the housing is tight and no

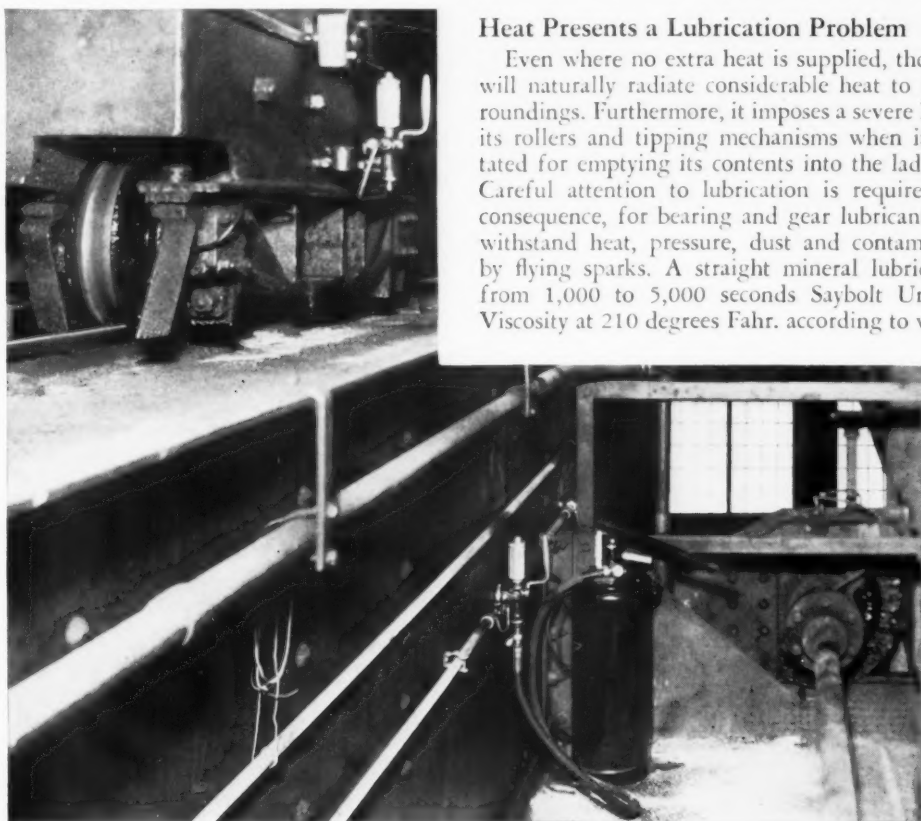
carelessness can so disarrange it as to expose the bearing or lubricant to the detrimental action of hot iron, slag, dust, dirt or water.

THE MIXER

Pig iron is kept molten in a mixer, after it has been poured from the blast furnace. This may be necessary when immediate charging into the converters or open hearth is impracticable for any reason. Then the iron from the blast furnace is poured into a firebrick-lined ladle which is mounted on a suitable car for transportation to the mixer. This latter is simply a large receptacle of several hundred tons capacity which serves to keep the iron in molten state to uniformly mix the products of perhaps several blast furnaces and to desulphurize the metal to a certain extent. While the mixer usually does not heat the iron, it must always, however, be prepared to do so if necessary. Therefore, heating equipment of some sort is essential, depending in extent upon the nature of the fuel at hand. Gas, when available, is very satisfactory for this purpose.

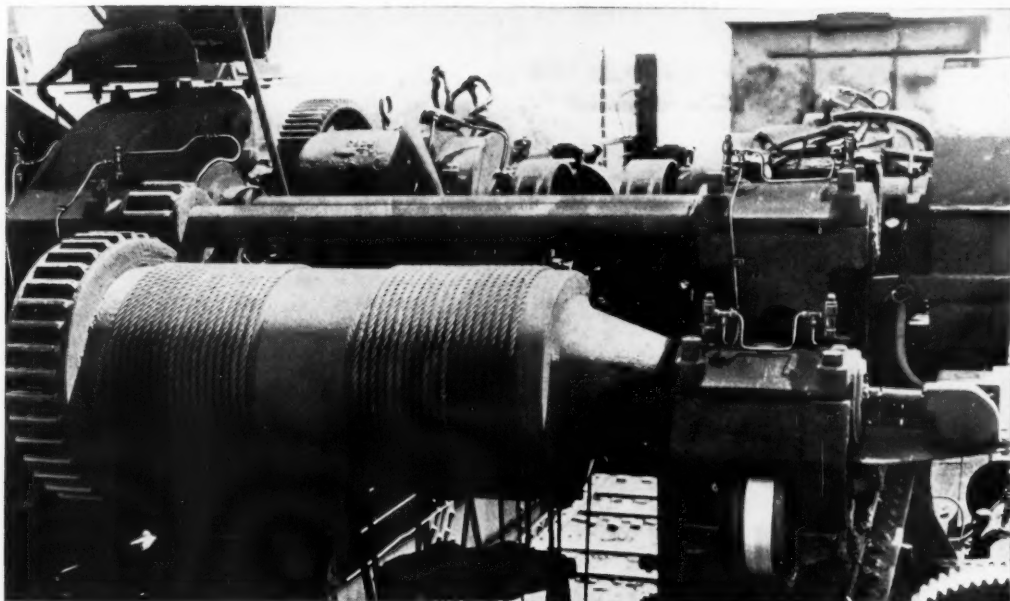
Heat Presents a Lubrication Problem

Even where no extra heat is supplied, the mixer will naturally radiate considerable heat to its surroundings. Furthermore, it imposes a severe load on its rollers and tipping mechanisms when it is rotated for emptying its contents into the ladle cars. Careful attention to lubrication is required as a consequence, for bearing and gear lubricants must withstand heat, pressure, dust and contamination by flying sparks. A straight mineral lubricant of from 1,000 to 5,000 seconds Saybolt Universal Viscosity at 210 degrees Fahr. according to weather



Courtesy of Stewart-Warner Corporation, Alemite Sales Division

Figure 6 — Showing an Alemite lubricant pump attached to the reversing valve which actuates the flow of lubricant to the bridge system of an overhead crane. Above the bridge note the trolley with the reversing valve which actuates the trolley system.



Courtesy of Stewart-Warner Corporation, Alemite Sales Division

Figure 7 — An Alemite centralized lubrication system on a crane trolley. This system is completely pressure tested each time it operates.

and temperature conditions has been found best suited for the gears. Bearings are usually hand lubricated with the exception of ring-oiled motor bearings. The latter require a good grade of medium viscosity engine oil; the other bearings can be protected with black oil. Centralized grease systems are successfully used on mixer rollers.

CONVERSION OF IRON TO STEEL

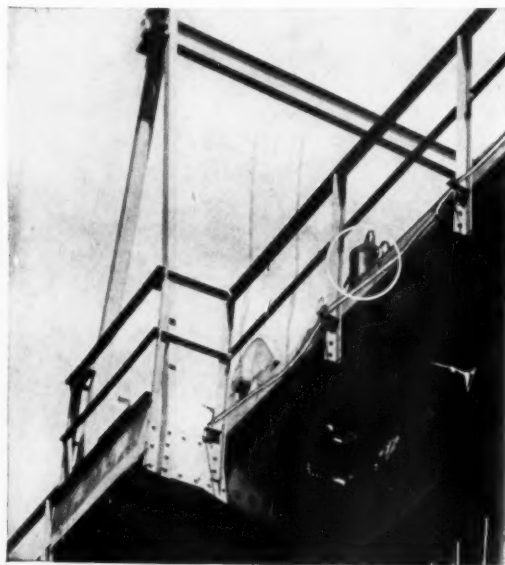
From the mixers the iron is transported to the Bessemer converter, the open hearth or electric furnace. The Bessemer converter was the original equipment used for the refining of iron, though the open hearth followed closely, being commercialized in about 1864. The open hearth has supplanted the Bessemer in production of most grades of steel because of more accurate control of elements other than carbon and silicon, and also because it permits of use of larger quantities of scrap in the charge. The electric furnace in turn is proving even more advantageous than the open hearth for production of alloy steels of exacting chemical characteristics. A large amount of electric furnace capacity has been installed during the past few years.

BESSEMER CONVERTERS

Conversion of iron to steel is a process of decarbonization and oxidation while the iron is in molten form. Sir Henry Bessemer invented the process which bears his name and announced it in 1856.

The Bessemer converter is a barrel-shaped steel shell. It is lined with refractory brick and clay rang-

ing from perhaps 12 to 18 inches in thickness. This serves as protection for the shell as well as a heat insulator. The bottom of the converter is closed, the top or neck being left open for pouring and the discharge of waste gases, etc., during the process of blowing.



Courtesy of Stewart-Warner Corporation, Alemite Sales Division

Figure 8 — Showing portion of the crane bridge (Fig. 7) with pump supplying system in circle.

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The Bessemer converter varies in size; usually, however, it will not be above 20 feet in height nor 16 feet in inside diameter. In the bottom or base of the converter are located the tuyeres or perforations through which the necessary air is blown into the charge during the blow. It is the oxidizing action of this air which burns away the silica, carbon and other non-ferrous elements originally contained in the charge of pig and scrap iron. While the burning off of each of these elements has a characteristic flame and is recognizable by the steel worker, it is the oxidation of carbon which really indicates the extent of completion of the blow by the shower of sparks which shoot from the mouth of the converter at this stage of the process.

When all the impurities have been burned off, the blow is stopped, the converter turned and such elements are added as are necessary to give the resultant steel the necessary characteristics. The metal is then poured into a ladle, after which it is ready for casting as ingots.

Converters of this type normally hang in a vertical position, being mounted at the center upon trunnions which permit tipping for the purpose of charging and pouring. For this reason, the air connections which are generally made through one of the trunnions, must be flexible to a certain extent in order that the converter may be blown in any position.

The initial charge, whatever its nature, must be molten. Some plants, therefore, take the product directly from their blast furnaces or mixers; others use cold pig iron, melting it in cupolas before

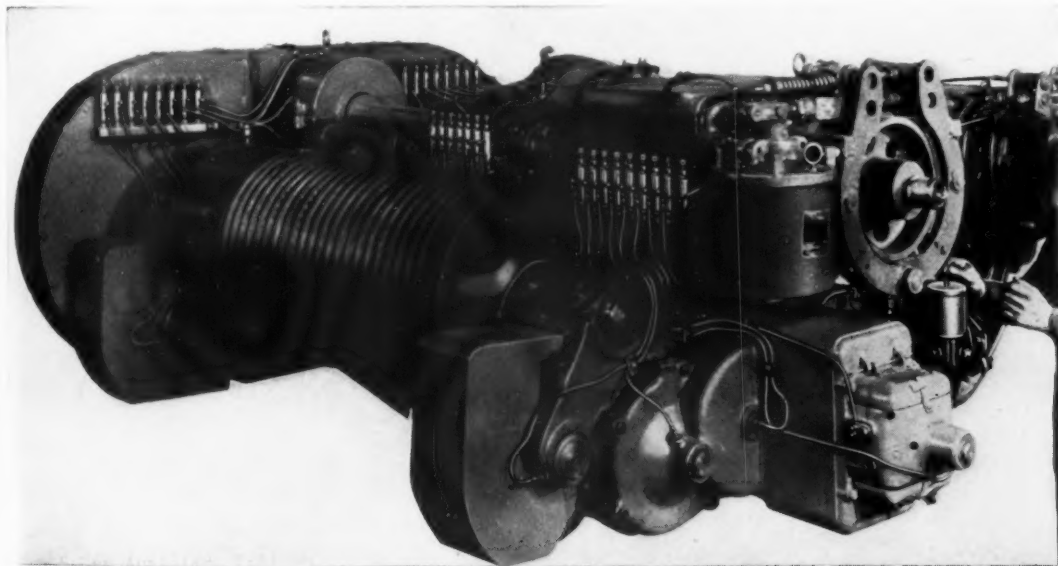
charging. After sufficient molten metal has been charged, however, solid pigs or scrap iron may be dropped in without damage to the lining since they will become instantly plastic and soon melted, due to the heat of the molten charge. The air blast must be started immediately after charging, as the converter is tipped upright.

Lubrication of the Bessemer

The converter has to operate, and be free to swing readily when charging or pouring is done, therefore, the operating mechanism which comprises a pair of hydraulic plungers with suitable racks and pinions adjacent to the trunnions, must work with the least possible friction, otherwise the power consumption and time of turning might be rapidly increased. This holds true regardless of the heat. That is why a lubrication problem is involved, so the lubricant must be heat resisting to the highest degree. A straight mineral product of around 1,000 Seconds Saybolt Universal Viscosity at 210 degrees Fahr. due to its adhesive characteristics has been found to meet the converter's requirements satisfactorily.

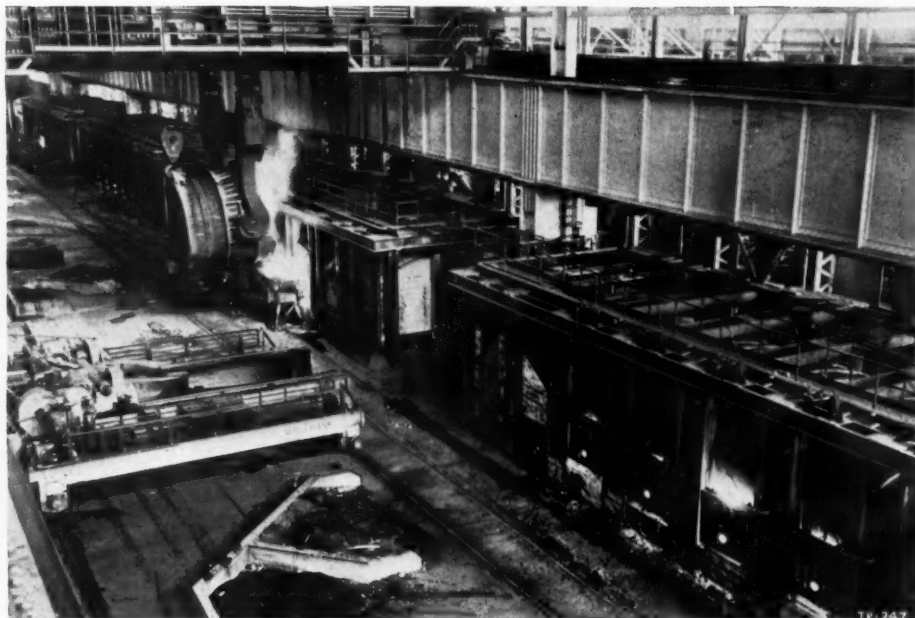
The air blast for blowing (as already mentioned) may be supplied by either horizontal or vertical steam driven blowers or turbo-blowers. These normally are located in engine rooms apart from the converters, so their lubrication, involving circulating oiling systems or mechanical force feed lubricators is similar to that of any power plant unit.

Steel is poured from the Bessemer into a ladle for transfer to the ingot moulds. The cranes which



Courtesy of Lincoln Engineering Company

Figure 9 — A 5-ton auxiliary unit on a 25-ton Harnischfeger crane, equipped with Lincoln Centro-Matic centralized lubricating system.



Courtesy of Trabon Engineering Corporation

Figure 10 — An open hearth charging floor. The charging machines here are lubricated by Trabon manually operated reversing systems.

handle these ladles are motor driven. The presence of heat, slag and dust naturally imposes the same severe requirements upon the lubricant as elsewhere in this part of the plant; as a result lubrication of gears and bearings often becomes quite a serious problem. If the gear lubricant as recommended for converter gears is used, with a good black oil for bearings and journals, many of the lubricating difficulties will be eliminated.

Some ladle cranes are equipped with automatic centralized lubricating systems so controlled that after a pre-determined number of lifts, the system automatically cuts in and lubricates the entire crane.

OPEN HEARTH FURNACES

Steels of very definite properties can be produced in the open hearth. This process also takes a larger volume of pig iron and scrap than the Bessemer. The necessary heat for melting and refining the iron is obtained from coke oven gas, fuel oil or natural gas. Fuel oil is an important factor in such plants as have limited gas equipment.

Iron is charged both in solid and molten condition. Scrap of any sort is loaded into charging boxes carried on suitable cars, and dumped into furnaces by means of an electrically operated charging crane. The usual order of charging such a furnace is to spread a layer of limestone over the bottom, load in the scrap, heat it to a moderate temperature, and pour in the molten pig iron from a ladle via a suitable trough.

The charging doors are then closed and firing is started to render the entire charge molten. During the "heat" samples or "buttons" must be periodically taken for chemical analysis or observation, to determine how refinement is proceeding. The melter's skill and experience enable him to read the characteristics of the metal in the bath from a fractured sample.

When the desired grade of steel is indicated, the charge is poured into a bricklined ladle, of sufficient size to hold the entire output of one furnace "heat." The tap hole is generally located on the opposite side of the furnace from the charging doors, near the bottom. The ladle is built with a bottom outlet, so that it can in turn be tapped and its contents run into ingot moulds, just as is done in the Bessemer plant. This is the process of casting steel. These moulds are mounted on suitable ingot cars, the journals of which are often equipped with roller bearings. Thirty ingots comprise the "pour" from an average open hearth furnace.

Pouring ingots from either the open hearth or Bessemer converter requires care and skill in order to insure uniformity of metallic structure throughout. The wrong temperature can often render an ingot unsuitable for rolling due to the formation of cavities caused by uneven cooling and retention of gases.

Ingots must be allowed to remain in their moulds for a sufficient length of time to insure solidification.

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They are then "stripped" or removed by means of an electric stripper. This device consists of a pair of jaws within which is a suitable plunger. The entire mechanism is crane operated, ingot cars being run underneath, and the stripper moved from one to the other. Each ingot in succession is removed by gripping the mould with the jaws, the plunger meanwhile bearing against the top of the ingot. The jaws and mould are then raised, the plunger holding the ingot down on the car.

High Temperature Lubrication Prevails

With the exception of the charging cranes, overhead traveling cranes, strippers and operating mechanisms for raising and lowering the charging doors, the open hearth plant has relatively little machinery requiring lubrication. This equipment is electrically operated. The overhead traveling cranes which handle the metal ladles are the most important hoisting devices involved; they may run as high as 300 tons capacity. All have at least two separate hoists, the smaller or auxiliary being oftentimes as powerful as in the average crane found on other work.

Heat and contamination are the chief causes of impaired lubrication. The cables, gears, bearings, hoists and trolleys of all the mechanisms are periodically exposed to the extreme heat of molten metal and hot gases which arise from the molten steel during tapping. This applies particularly to the cables holding the hooks which raise the ladles. Lubricants which are not specially refined will tend to dry up and lose their effectiveness rapidly under these conditions.

Where induced draft fans force the hot gases from the open hearth through a series of waste heat boilers, the lubrication of the bearings of these fans also can become difficult due to the heat from the hot gases which is conducted by the shaft to the bearings. These fans are usually motor driven, being equipped with watercooled, ring-oiled bearings. Relatively high viscosity engine oil, or even, in some cases a steam refined cylinder stock must be used to meet conditions and afford the necessary lubrication.

THE ELECTRIC FURNACE

While the open hearth furnace is remarkable for the accuracy with which it turns out steels of practically any desired characteristics, even better products are said to be obtainable through the use of the electric furnace and the adaptation of the electric arc. The electric furnace consists of a bowl-shaped steel shell suitably lined with firebrick or other refractory material. To the bottom is attached a toothed rocker which meshes with a rack. Thus the furnace can be tilted for pouring, by setting in motion the operating motor which manipulates the furnace through a connecting rod and a reduction

gear. The lining of the electric furnace is a very important feature, just as it is in the Bessemer converter and open hearth. Usually three layers of several inches each of different refractories are used. Through the roof or dome, which is also heavily constructed of refractory brick, projects the carbon electrodes. These transmit the necessary electric current to the charge of molten iron, limestone and other necessary ingredients which must be used to reduce the iron oxides and remove sulphur and phosphorous. Later on, elements such as nickel, chromium, manganese or vanadium, are added in measured quantities according to the grade of steel and the nature of the alloy which is desired. The passage of electric current through the charge in the furnace brings about temperatures as high as 3,000 degrees Fahr. during the process of refinement. The extent to which such temperatures can be controlled is one of the outstanding advantages of the electric furnace. In general it will require from four to five hours per heat, in such a furnace, in contrast to the Bessemer which takes about 15 minutes and the open hearth which may require perhaps 6 to 12 hours to do the same work.

Lubrication

The usual mechanisms which will require lubrication in the electric furnace are the rack and gear teeth, the bearings of the operating motor and connecting rod and the electrode hoist winches. A considerable number of such parts are involved. In general, heat conditions will not be quite as severe, nor will these mechanisms be subject to as dusty operation as elsewhere in the mill. Therefore the usual lubricants specified heretofore for similar mechanisms will function with perfect satisfaction, in fact, will last longer and give better service than when operating conditions and temperatures are more severe.

CONCLUSION

Although but a fleeting picture of the smelting and refining branches of the steel industry has been given, it is felt that sufficient has been said to bring out the particularly important part which is played by lubrication. To be true, the average equipment is rough and massive and first glance would lead one to believe that lubrication is not a serious matter. But the operating mechanisms of these massive units must be accurately designed and machined, since they are so inter-dependent upon one another. In effect, the principles of good machine-work must be incorporated in the steel mill as everywhere else in industry, if efficient production is to result.

Accordingly lubrication of moving or rubbing parts becomes of the most vital importance, for in company with the usual problems of pressures and clearances, heat, dust and dirt are encountered in their most aggravating form.

TEXACO LUBRICATION RECOMMENDATIONS

FOR STEEL MILLS

BLAST FURNACE EQUIPMENT

STOCK HOUSE	
Belt Conveyor Rollers — Pressure Fittings.....	Texaco H Grease No. 1
SKIP-CAR WHEEL BEARINGS — Roller Type.....	Texaco H Grease No. 1
SKIP-HOIST DRUM — Plain Bearings.....	Texaco H Grease No. 1
LARRY AND LADLE CAR WHEEL BEARINGS — MCB Type.....	Texaco Wool Yarn Elastic Grease
BELL MECHANISM — Pressure Fittings.....	Texaco Marfak No. 1 or No. 3
MUD GUN STEAM CYLINDER.....	Texaco Pinnacle Cylinder Oil

POWER EQUIPMENT

BLOWING ENGINES	
Steam Cylinders	
Pressures above 150 lbs.....	Texaco 650T Cylinder Oil
Pressures below 150 lbs.....	Texaco Pinnacle Cylinder Oil
Air Cylinders or Tubs.....	Texaco Ursa Oil X-50**
	Texaco Pelican Oil or
	Texaco Aries Oil
Bearings, Crank Pins	Texaco Aleph Oil or
	Texaco Altair Oil
AIR COMPRESSORS	Texaco Alcaid Oil or Algol
	Texaco Regal Oils (R&O)
ELECTRIC MOTOR BEARINGS	
Oil Lubricated	Texaco Alcaid Oil or
Grease Lubricated	Texaco Regal Oils (R&O)
	Texaco Regal Starfak No. 2
STEAM TURBINES AND GENERATORS	
Direct Connected	
Bearings and Governor Mechanisms.....	Texaco Regal Oil A (R&O) or B (R&O)
Geared Turbines	
Gears and Bearings.....	Texaco Regal Oil PC (R&O) or PE (R&O)
Combustion Control Regulators — Hydraulic Medium.....	Texaco Regal Oils (R&O)
Induced or Forced Draft Fans and Speed Reducers.....	Texaco Regal Oil PE (R&O)

MIXERS AND BESSEMER CONVERTERS

TRUNNION ROLLERS AND BEARINGS	
Oil Lubricated	Texaco Meropa Lubricant 6
Grease Lubricated	Texaco Marfak No. 1 or No. 3
TILTING MECHANISM	
Worm Drive — Enclosed	Texaco Meropa Lubricants
Open Gears — Rack and Pinion.....	Texaco Crater 2X or 3X Fluid
HYDRAULIC PLUNGERS	Texaco Meropa Lubricants Nos. 5 or 6
	Texaco Crater Fluids or
	Texaco Grease XG No. 2

OPEN HEARTH DEPARTMENT

FURNACE DOOR MECHANISM — Speed Reducers.....	Texaco Regal Oil PE (R&O)
FUEL REVERSING VALVES — Steam Cylinders.....	Texaco Pinnacle Cylinder Oil
AIR INTAKE OR MUSHROOM VALVE MECHANISM	
Enclosed Reduction Gears	Texaco Meropa Lubricant 6
Enclosed Worm Gears	Texaco Meropa Lubricants
CHARGING-PAN, INGOT, AND SLAG LADLE CAR JOURNALS	
MCB Type Bearings — Waste Packed.....	Texaco Pelican Oil or
	Texaco No. 747 Oil
Roller Bearings	Texaco Marfak Heavy Duty No. 2 or
	Heavy Duty No. 3
LADLE AND CHARGING-FLOOR CRANES	
Track Wheel Gears.....	Texaco Crater No. 0 or No. 1
Track Wheel — Roller Bearings.....	Texaco Marfak Heavy Duty No. 2 or
	Heavy Duty No. 3
Waste Packed MCB Type Bearings.....	Texaco Pelican Oil or
	Texaco No. 747 Oil
Reduction Gears — Exposed	Texaco Crater 2X Fluid or 5X Fluid
Enclosed Speed Reducers.....	Texaco Meropa Lubricants

SOAKING PITS AND INGOT BUGGIES

Open Gears	Texaco Crater No. 5X, Crater 5X Fluid; or
	Crater No. 10X
Enclosed Gears (Bath Lub.).....	Texaco Meropa Lubricants or
	Texaco 650T Cylinder Oil

Worm Gears on Pit Covers & Buggies.....	{ Texaco Meropa Lubricants or Texaco 650T Cylinder Oil
Pit Cover Hydraulic Plungers	{ Texaco Meropa Lubricants or Texaco Grease No. 2XG
BEARINGS	
Plain Sleeve Type	Texaco No. 629 Oil or Black Oil
Ball or Roller.....	Texaco Marfak Heavy Duty No. 2 or No. 3
Car Wheel Journals.....	Texaco No. 747 Oil or No. 629 Oil

ROLLING MILL EQUIPMENT

MILL TABLE ROLLS AND CONVEYOR TABLE BEARINGS

Oil Lubricated	
Plain Bearings	Texaco 629 Oil or Black Oil
Anti-Friction Bearings	Texaco Regal Oils H, J, K or L
Grease Lubricated	Texaco Marfak or Grease EP No. 1

CONVEYOR TABLE GEARS

Open	{ Texaco Crater No. 2X, Crater 2X Fluid, Crater No. 5X, Crater 5X Fluid, or Crater No. 10X
Enclosed	{ Texaco Meropa Lubricants, Texaco Regal Oil J or Texaco Crater No. 00
Main Motor Drive Bearings.....	Texaco Regal Oil B (R&O) or PC (R&O)

MAIN REDUCTION GEAR DRIVES AND PINION HOUSINGS

Enclosed Gears	
Main Reduction Drives.....	{ Texaco Regal Oils H, J, K or L; or Texaco Meropa Lubricants
Pinion Stands	Texaco Meropa Lubricants
Open Gears	{ Texaco Crater No. 2X, Crater 2X Fluid or Crater No. 5X, or Crater 5X Fluid
Plain Bearings	
Oil Lubricated	Texaco Regal Oils
Plain Bearings	
Grease Lubricated	{ Texaco Grease EP No. 1, EP No. 2 or Texaco H Grease No. 1 or No. 2
Roller Bearings	
Automatic Grease System.....	Texaco Grease EP No. 1 or EP No. 2

ROLL STANDS

Screws and Screw-down Drive.....	Texaco Meropa Lubricants
Roll Neck Bearings	
Plain (Hand Packed)	Texaco Texmill Grease 40, 50, 60
Plain (Grease System).....	{ Texaco Grease EP No. 1 or EP No. 2; or Texaco H Grease No. 1 or No. 2
(Oil Circulated)	Texaco Regal Oil H, J, K or L
Roller (Grease System).....	{ Texaco Grease EP No. 1 or EP No. 2 or Texaco Marfak Heavy Duty EP No. 1
Edging Mill Drives	{ Texaco Meropa Lubricants Texaco Regal Oils (R&O)
Coiler Roller Bearings	{ Texaco H Grease No. 1 or Texaco Grease EP No. 1
Universal Couplings	{ Texaco Grease EP No. 1 Texaco Grease XG No. 2
Roll Balance Uncoiler	
(Hydraulic Fluid)	Texaco Regal Oils (R&O)

ACCESSORY EQUIPMENT

Hot-Bed Skids and Guides.....	Texaco Crater No. 10X
Hot-Bed Wire Ropes.....	Texaco Crater No. 0 or No. 00
Over-head Cranes	
Open Gears	Texaco Crater 2X Fluid or 5X Fluid
Oil Bearings	Texaco Algol Oil or No. 747 Oil
Grease Bearings (plain).....	{ Texaco Marfak Heavy Duty No. 2 or Texaco Grease No. 1 EP or No. 2 EP
Track Wheels (Roller Bearings).....	{ Texaco Marfak or Texaco Grease EP No. 1 or EP No. 2
Track Wheels (Plain Bearings).....	Texaco Wool Yarn Elastic Grease
Cables	Texaco Crater A or Crater 2X Fluid

HOT AND COLD SAW BEARINGS

(High Speed)	
Ring Oiled or Circulating System.....	Texaco Regal Oil B (R&O)
Grease Bearings	
Plain or Roller	{ Texaco Regal Starfak or Texaco Grease EP No. 1 or EP No. 2

HYDRAULIC ACCUMULATOR

Plungers	{ Texaco Grease XG No. 2 Texaco Meropa Lubricant 5 or 6
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